TOMATO DISEASES.

By C. C. Brittlebank, Vegetable Pathologist.

"Bacterial Wilt."

Bacillus solanacearum, E. F. Smith.

This is the cause of the well-known potato disease "Sore Eye" or "Wet Rot." In the tomato, as well as in the potato, there is a sudden wilting of the plants, the result partly of the water supply being cut off by the blocking of the water-bearing vessels by the bacteria and their products.

All wilted plants should be removed and burned as soon as observed. Land on which this disease has occurred should not be used for tomatoes, potato, capsicum, or tobacco crops for an interval of two or three years. The disease can be carried from diseased to healthy plants by gnawing insects. For the control of insects, spray with 2 lbs. of arsenate of lead in 50 gallons of water. Fortunately, "Bacterial Wilt" is not, so far, common in the tomato fields of this State.

Irish Potato Blight.

Phytophthora infestans, De Bry.

In the drier portions of Victoria, Potato Blight has not caused any considerable loss to tomato-growers. Besides the potato and tomato, a native solanum, *Solanum aviculare*, has contracted the disease.

Weather conditions are the predominant factors in the spread of this disease. Heavy continued rains in January, February, and March with cloudy muggy weather are favorable to the development of potato blight in the tomato. As a rule, the fruit is more commonly attacked than the leaves.

On the leaves, dark-brown or black blotches appear, generally at the tips or sides. On the undersurface of these diseased areas a fine greyish-white mould will be noticeable if the weather be warm and moist. This mould is composed of upright branching filaments, on the free tips of which are borne numerous lemon-shaped sporangia.

Dark streaks will show on the stems and leaf stalks—these, as well as those on the leaf, extend until the whole plant is black and dead. On the fruit, slightly-sunken irregular areas appear—brownish-red in colour—and of a varying size. If the fruit be cut through, the flesh will be found to be brownish and mottled, and somewhat firmer than the healthy fruit. Spraying with 8, 10, 40 copper-soda should not be delayed if the disease is observed, and it is better to anticipate it and spray to prevent rather than to wait until the disease is present.

Climatic conditions favorable to the development of Potato Blight also favour the development of other diseases which attack tomatoes. Spraying should be carried out whenever weather conditions permit.

Wilt, "Sleepy Disease."

Fusarium lycopersici, Sacc.

The sleepy disease is caused by a parasitic fungus, *F. lycopersici,* Sacc., which gains entrance into the plant through the roots. Plants are liable to attack by this fungus at all stages of growth from the time they are seedlings until they are in full fruit. Young plants when attacked fail to keep pace with the healthy ones in growth; their leaves assume a sickly yellow, and the lower ones fall. Other plants show the effects of the disease when the first cluster of fruit is about to ripen, and it is seldom that any plants attain a greater development, the last symptom being a sudden wilting, and death quickly follows. When the fungus has gained entrance into the tissue of the plant it cannot be controlled, and plants should be destroyed as soon as it is seen they are contaminated.

In some tomato-growing countries the sleepy disease or wilt has caused very serious losses, and it is common to have every plant in large blocks killed off just as they are coming into bearing. Fortunately, however, neither the Bacterial nor the Fusarium Wilt has yet caused any marked loss in those districts of our State most suited to tomato culture. Every care should be taken, therefore, to check the first outbreak. When once the Fusarium has invaded the soil, it is most difficult to eradicate, soil treatment being too expensive. The only means of clearing large areas is by rotation of crops; and, as the fungus is known to remain in the earth for seven years, it would be a great loss to growers for tomato land to lie idle for this long period.

Target Spot.

Alternaria solani (E.M.) Jones, et. Gront.

This disease is one of importance to the tomato grower. Plants may be attacked at any stage of growth, from the seedling to the plant in full bearing.

Symptoms of attack are—On the leaves well-defined and more or less circular spots develop; these rapidly increase in size until in cases of virulent attack they become confluent.

If the spots be carefully examined they will be found to be marked by concentric rings, hence the common name "Target Spot." These rings indicate the stages of growth made by the fungus within the tissue of the leaf.

On the stem and leaf stalks black or brownish-black streaks and spots show. Later, the whole plant assumes a sickly yellow colour, with the leaves blotched yellow and folded inwards.

Fruit affected by "Target Spot" develops sunken or depressed spots and blotches beneath the skin. In time a dark mould appears on the diseased spots, and the fruit rapidly decays.

Control—Cultivate and stimulate the growing plants, for usually the disease is in part due to their want of vigour. Spray with 6.9.50 copper soda as soon as the disease appears. A second spraying must follow within seven days, and a third later, if necessary.

Good results have been obtained by the above-mentioned method of control. At one place several thousand bearing plants, under glass, were badly attacked. They, as well as the glass, benches, and floor of the house were sprayed as directed, with the results that the disease was completely controlled, and did not appear in the tomatoes grown in the house during the same or following year.

Spotting of the leaves and stem is a feature of this disease, as well as in the one known as "Spotted Wilt"; therefore, care should be taken in examining the leaves to ascertain if the spots show the concentric rings. Spots caused by the "Target Spot" are much more definite than those caused by the "Spotted Wilt." Spraying with copper soda has no effect on "Spotted Wilt."

SEEDLING DISEASES.

There is no period in the life-cycle of the tomato more critical than that of the seedling stage. The treatment given in the initial stages of the life of a plant or animal has a marked influence on its ultimate success. This is more noticeable in short-lived plants than in those which attain a great age. Consequently, better yields may be looked for from vigorous tomato plants than from those which have been checked by disease while seedlings.

It should be the aim of the grower to raise clean plants; to this end he must use every care to see that the soil of the seed bed is freed from fungi liable to attack seedlings. This can in a great measure, be attained by sterilization of the soil by steam, or by using virgin soil to which an admixture of lime has been added. Steps should be taken to exclude diseased material from previous crops gaining entrance to this soil. Many growers foolishly use the same earth in the seed beds year after year, and when new beds are required old dead tomato plants are collected and mixed up with the soil. Such practices will bring about conditions under which it will be impossible to produce healthy plants. In those districts where the extensive and intense culture of the tomato is practised, diseases will be more common and more difficult to control than in the past. This is due to the fact that there are many more centres of infection from which the disease can spread to the adjacent blocks.

Root Rot.

Rhizoctonia solani, Keuhn.

One of the most destructive seed-bed troubles is caused by the fungus known as *Rhizoctonia solani*, Keuhn. This is essentially a soil-inhabiting fungus; therefore, earth containing it, if used for seed beds, will produce diseased seedlings if the temperature and the water-content of the soil be high.

Unfortunately, quantities of the soil used in the suburban districts for seed beds is naturally infected, and consequently many of the young plants when sold fail to thrive, or remain stunted and produce a light worthless crop.

Seedlings in their early stages when affected by Rhizoctonia have the edges of the leaves folded upward and inward, their tips purple or bluish-purple. Later, the plants rot at slightly below the soil

surface and topple over. This severe form of attack may affect a few plants scattered through the seed bed, or it may spread outward from the center of infection, killing all the plants in the bed. In milder attacks, the plants remain stunted, with the lower leaves yellow, the upper folded inwards, and the crown leaves crowded and slightly rigid and of a greenish purple.

If the roots of one of these plants be carefully examined, very fine dark-brown threads will be observed; they will also be noticeable on the underground stem and at the collar of the plant.

Microscopic examination of the roots in section will show that the fungus has invaded the cells, causing injury and death to the invaded roots, but not to such an extent as to kill the plant. Experiments carried out with a like number of diseased and healthy plants gave the following results:—The yield from the diseased plants was seventeen and a half times less than that taken from healthy bushes. Thousands of slightly diseased plants are sold annually round the suburbs of Melbourne, and this may account for the many failures to obtain a good return.

Control measures are of little or no avail where plants have their roots invaded by Rhizoctonia. Soil sterilization by steam should be carried out if possible. If this cannot be done, lime should be mixed with the soil at the rate of 1 cwt. to 5 cubic yards. The mixing should be done about six months before the soil is to be used. After mixing the lime, the soil should be turned over at least twice before it is brought into use. Water should be used as sparingly as possible, and the temperature kept between 68 to 72 deg. Fahr. The control measures suggested have been followed by several of the largest growers of tomato plants with perfect success. "Root Rot" in former years destroyed many thousands of seedlings, but at the present time no loss occurs in the houses where the above directions are carried out.

Damping Off Disease.

Pythium de baryanum, Hesse.

"Damping Off" is another disease which attacks young tomato and other plants.

Symptoms: The plants appear sickly, soon decay at the collar, and fall over and perish. The roots, as a rule, are not injured, the point of attack being just at or below the soil surface. Whole trays are killed off within a few days. As the fungus remains in the soil for some considerable time, the trays and soil should on no account be used again until they have been sterilized.

When this disease appears among seedlings, it can be taken as a sign that too much water and too little ventilation have been given, and that the temperature has been kept too high.

"Damping Off" is often difficult to control, but favorable results have been obtained by a heavy drenching of the plants and soil with 6 lbs. of bluestone and 9 lbs. of washing soda in 100 gallons of water, or by dusting the plants with sulphur. This treatment, together with careful watering and good ventilation, should hold this disease in check.

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ELECTRO-CULTURE.

A GENERAL REVIEW OF THE SUBJECT.

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At the present moment there is a serious world shortage of foodstuffs and of raw materials. Increase in production, whether by increasing the area under cultivation or by the use of improved methods, is a vital necessity. In the present state of the world's unrest it is highly probable that the shortage will be severely felt for a long time to come, and the maxim that the man who can make two blades of grass grow where one grew before is entitled to rank as a public benefactor, is probably more true to-day than ever before.

While it may not be immediately possible to double the yields from our present areas, still it behoves us to be ever on the alert to take advantage of any development that may tend in the direction of increased production, and it is fitting that serious consideration should be given to any practical proposal for increasing the fertility of the soil. It is with the object of directing attention to a somewhat obscure and little heard of branch of agriculture that the present account of the subject of Electro-culture is written.

Many people have a deep-rooted distrust of what they call "new-fangled ideas," and this, combined with the general lack of knowledge of electricity, has made them slow to examine the results or to take advantage of the benefits claimed for Electro-culture. Thus the matter has been left, and still is in the hands of a few enthusiasts, some of whom have conducted costly experiments for many years with varying success, but always with the indication that greatly increased yields were obtainable if only the electrical stimulus could be applied in the right way.

HISTORICAL.

The idea of stimulating the growth of plants by the use of electricity is not a new one. The earliest known experiments were carried out at Edinburgh by Dr. Mainbray, a Scottish physician, over 160 years ago (1746). Even before this time there seems to have been a popular belief that electrical discharges (thunderstorms) were in some way concerned in stimulating the growth of plants. The general failure of the hop crop in 1787 was attributed, rightly or wrongly, to the almost entire absence of lightning for the season.

Mainbray experimented with young myrtle trees, and demonstrated that electricity accelerated growth. During the next fifty years his experiments were repeated and his observations confirmed by numerous experimenters. The scope of the experiments was gradually enlarged; tests were made with a great variety of plants, and some attempt was made as early as 1747 (the year after Mainbray's experiments) to explain the reasons for the various phenomena observed. The general results recorded were that plants when stimulated by electricity grew more vigorously, had larger leaves, and that they flowered and matured earlier.

In 1783 Berthelon was the first to attempt to apply the use of electricity to the production of crops, and he even went so far as to recommend its use as a remedy for fungus diseases and insect pests. It may be interesting to note at this stage that experiments conducted over 100 years after Berthelon's time, have also demonstrated that crops under the influence of electrical discharge suffer less from the attacks of fungus diseases than others. In this and in other respects Berthelon seems to have been ahead of his time. He also investigated the effect of electrified water on plants, and he electrified seeds by wrapping them individually in tinfoil. He seems to have been the first to consider some of the problems of electro-culture that are engaging most attention at the present time, and which will be discussed later. A quaint old print shows him mounted on an insulated truck being drawn around the garden while he applied electrified water to his plants.

For a period of 100 years after Berthelon's time nothing of outstanding importance seems to have been accomplished, till in 1885 Lemstrom commenced a series of experiments, and became the founder of much of the more modern experimental work in effects of electricity on plant growth. He states that his attention was first directed to the subject by observing the prolific growth of plants during his explorations in high (polar) latitudes. He suspected that this growth was due to the electrical discharges associated with auroral displays, and claimed that the very structure of these plants—needle leaves of the pine and the awns of cereals—fitted them for collecting the current that is known to be passing from the atmosphere to the earth. On his return he began experimenting. His plan was to stretch above the ground a network of wires well insulated from the earth. These wires, which were provided with points making them look somewhat like barbed wire, were highly charged with electricity which escaped from the points across the intervening airspace, through the plants to the soil. This method, though modified by other experimenters (amongst them Sir Oliver Lodge) is still in use.

More recent developments include the electro-chemical treatment of seeds, but this aspect of the subject will be dealt with later on.

MODES OF APPLICATION.

The results that have been collected by all of these experiments have established beyond all doubt that beneficial effects are to be obtained by the application of electrical stimulus to plants or seeds. The big problem is, "*How can this stimulus be most economically and effectively applied?*" The experiments so far conducted fall into classes that differ mainly in the mode of application of the electric current—

(1) Illumination by electric light.
(2) Conduction of atmospheric electricity from elevated conductors to the soil.
(3) Burying plates of copper and zinc in the soil and using the soil as an electrolyte.
(4) Passing a current through the soil from external sources.
(5) Silent discharge from antennæ or overhead network.
(6) Electro-chemical treatment of seeds.

These classes simply represent the different methods used by various experimenters in their attempts to apply electrical stimulus to plants or seeds. A brief account of each of these methods may prove of interest. It is, of course, impossible in a brief review of this description to enter into a discussion of the precise details of the experiments. The results achieved are our chief concern. The use of technical language has as far as possible been avoided.

(1) Illumination by Electric Light.

Experiments in this direction were commenced soon after the discovery of the electric arc light, and many curious results were observed. It was soon discovered that the naked arc light caused damage to plants, but when screened by a transparent glass screen the harmful effects were removed, and very beneficial results obtained.

The effect of the glass screen or a glass globe was to cut out the harmful rays. Numerous other forms of electric light, such as the incandescent electric light, &c., have been tried, and, generally speaking, the results have been good, though all plants are not similarly affected. The use of lights on a big scale is not practicable, so that its application has been restricted to market garden and greenhouse plants. Rawson —a Boston market gardener—has used electric light in raising lettuces for many years with great success. Lights of various colours have also been tried, and the development of produce can be hastened or retarded by their use.

The results obtained at the West Virginia Experimental Station may be summed up as follows (Bulletin 37):—

(i) Electric light is beneficial to some plants for foliage—lettuce.
(ii) Leaves of deeper green.
(iii) Flowers bloomed earlier and longer and were of deeper colour.
(iv) Some plants tend to run to seed—spinach.
(v) Does not benefit all plants equally.

It is claimed that electric light is to be regarded as a valuable asset in the forcing of market garden and greenhouse produce, and in producing fruits and flowers out of season. Mr. Lunt, of Spreydon, New Zealand, has used electric light in his glasshouse for raising tomatoes.

Light used from 9 p.m. to 5 a.m. gave beneficial effect on quantity, quality, and recovery from frost-bite. Apart from the stimulating effect of the light itself there is the factor of warmth associated with the light. Attempts have therefore been made to use electric lights with the object of preventing damage by frost. This is only possible where current is readily available at a low rate, as is the case where hydro-electric schemes have been carried out. The experience of Mr. Farr, orchardist at Fendalton, New Zealand, in this respect is interesting. In his pear and apple orchard he placed a 250-watt radiator in each tree with the object of preventing damage by frost. Frost-bite was prevented, and though there was no increased yield of pears the apples produced an abnormally heavy crop, and were ready for market a fortnight earlier than those in adjacent orchards.—*Journal of Agriculture,* New Zealand, vol. xv., p. 185.

It was while engaged in investigating the effect of electric light on plants that Dr. C. W. Siemans (England) originated the term "Electro-Horticulture," which is still generally used for work of this description, though the wider term "Electro-culture" is now used to embrace the application of electricity in any way to the production of any sort of plant.

Writers in our daily papers occasionally draw attention to the abnormal behaviour of some plant or tree putting out leaves, &c., at some unusual season when situated within the sphere of influence of some street light. It is possible that such behaviour is in a measure due to the influence of the light.

(2) Conduction of Atmospheric Electricity from Elevated Conductors to the Soil.

Attempts to make use of atmospheric electricity by collecting it by means of elevated conductors for discharge either directly into the soil or from an overhead system of wires, seem to have been confined mainly to France. The possibilities of utilizing atmospheric electricity, and even the part that it undoubtedly plays in influencing plant growth, have never been adequately investigated, and little is known about the subject. That such an influence does exist was proved by Grandeau (1879) when he demonstrated that plants protected from atmospheric electricity had their development much retarded. A big field for research is left practically untouched. However, some experiments have been carried out. The general method employed is to attach a conductor to a tall tower, and to connect this with buried plates or networks of wire. Few accounts of these experiments are available, so that it is only possible to refer to them in passing. The cost of the installation would be considerable, and large increases would be necessary to justify the expense. The following results are recorded by F. Paulin, a French experimenter:—

(i) Increased per cent. germination.
(ii) Potatoes, 50 per cent. increase.
(iii) Cauliflowers, matured one month early.
(iv) Beans and peas, 200 per cent. increase.

Experimental Station Record, vol. xv., p. 361.